



Identifying effective message-framing techniques in behaviour change communication for healthy diets: An experimental study of promoting biofortified maize adoption in Ethiopia

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ABSTRACT

There is an increasing interest in using insights from behavioural economics and psychology to influence people's decisions. However, little is known as to how to leverage these insights to inform educational campaigns in the context of nutrition-sensitive agriculture. We help to fill this void by investigating the effect of framed messages (gain vs loss) in stimulating demand for nutritionally enhanced crops. We conducted a field experiment with 648 farmers and found the following key results. First, nutrition education stimulates demand for nutritionally enhanced crops among smallholder farmers. Without nutrition education, farmers are less likely to switch from producing conventional maize to nutritionally enhanced maize. Second, gain-framed messages are slightly more effective: they result in a higher willingness to pay for nutritionally enhanced maize than loss-framed messages. Third, motivational orientations and risk perceptions of individuals moderate the effect of the framed messages.

1. Introduction

Transforming food systems in order to deliver better nutritional outcomes to the growing global population is an immediate challenge and requires new ways of thinking and new approaches. The importance of agriculture as a core determinant of nutrition has long been recognized, and agricultural policies that incorporate nutritional outcomes have been promoted to address food and nutrition insecurity, particularly in developing countries (Gillespie & van den Bold, 2017; IFPRI, 2011; Ruel & Alderman, 2013). Paradoxically, a large share of family farmers, who are responsible for 80 per cent of the world's food supply, are food insecure (FAO, 2014). In recent years, the call to increase the nutritional status of smallholder farmers and their families through nutrition-sensitive agriculture has received a lot of attention (Ruel et al., 2018).

Promoting nutritionally enhanced food crops is one of the efforts resulting from such calls (Ruel et al., 2018). As smallholder families consume a substantial share of their produce, the cultivation of such crops would directly improve the quality of their diets. However, as is the case for many agricultural technologies, adoption rates are still low (Ruzzante et al., 2021). One factor that has hindered the wide adoption of nutritionally enhanced crops is the lack of information about their

nutritional benefits (Ruel et al., 2018; van Campenhout, 2021). As a result, raising awareness and filling the knowledge gap are used to stimulate demand (FAO, 2016; Kodish et al., 2015). Yet, motivating and sustaining a behaviour change may require moving beyond the provision of knowledge to the engagement of emotions and activation of motivations. It has long been noted that individuals' motivational orientation guides behaviour (Craig, 1917) and that framed messages activate this motivational system (Updegraff et al., 2007; Yan et al., 2010, 2012).

In this study, we aim to explore how insights from behavioural economics and psychology can be leveraged to inform educational campaigns in the context of nutrition-sensitive agriculture, *i.e.* agriculture that provides a positive contribution to the nutritional status of the farming family. This implies that the farmers are educated about the consequences of their production choices for the health of their family through home consumption of their produce. The following questions guide our study: 1) Is providing nutrition education messages effective in stimulating demand for nutritionally enhanced seeds? 2) How do differently framed nutrition messages affect farmers' willingness to pay (wtp) for nutritionally enhanced seeds? 3) How do individuals' motivational orientation and risk perception moderate the effectiveness of framed messages?

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The framing effect is derived from the prospect theory of [Tversky and Kahneman \(1981\)](#), who demonstrated that preferences depend on the formulation of decision problems. A key conclusion is that people tend to be risk-avoiding when contemplating gains and risk-seeking when contemplating losses. The health communication literature examines framing effects in a variety of settings ranging from encouraging health-seeking behaviour ([Banks et al., 1995](#); [Ye et al., 2021](#)) to physical activities ([Drouin et al., 2018](#)) to shaping attitude ([Jean et al., 2021](#)) to promoting healthy food choice ([Binder et al., 2020](#); [Elbert & Ots, 2018](#); [Godinho et al., 2016](#)). These studies explored the framing effect by providing gain- or loss-framed health messages and find support for the hypothesis that gain(loss)-framed messages would be effective in promoting safe(risky) behaviours in the health domain ([Meyerowitz & Chaiken, 1987](#); [Rothman & Salovey, 1997](#)). The key insight here is that the perceived risk associated with the advocated behaviour determines which message framing would be more effective in bringing about the intended behaviour changes. If there is significant variability in the way behaviour is construed (e.g., whether the behaviour is perceived risky or less risky), then messaging strategies that do not take these insights into account would be less effective.

However, the empirical results on the relationship between risk perception and framed messages are mixed ([Van't Riet et al., 2014](#)), indicating that there may be other relevant inter-individual differences that interact with risk perception. One of such differences is individual's regulatory focus. For instance, [Mann et al. \(2004\)](#) show that the dominant regulatory focus of individuals moderates the effectiveness of differently framed messages. This approach categorizes people into two groups: promotion focussed individuals and prevention focussed individuals. Promotion-focussed individuals are geared towards achieving something, while prevention focussed individuals are geared towards preventing negative things from happening ([Cesario et al., 2008](#)). By framing messages such that they fit the regulatory focus of individuals, it is possible to increase their impact ([Higgins, 2000](#)): With proper regulatory fit, decision makers feel right about the message; and their engagement is strong ([Cesario et al., 2008](#)). Put differently, a promotion focused individual would respond better to a gain framed message, whereas a prevention focused individual would respond better to a loss framed message. The implication is that apart from risk perception, an individual's dominant motivation system also moderates the framing effect. However, the interaction of these two moderators has not been studied.

A notable work in the health economic literature is by [List and Samek \(2015\)](#) who leveraged the framing effect to tackle child food choice and consumption. Unlike the literature in health communication, [List and Samek \(2015\)](#) explored the framing effect by using framed incentives. Children were given the choice between a healthy and an unhealthy snack. A random selection received a small price if they selected the healthy snack (gain frame incentive), and another random selection received a price but it was taken away if they selected the unhealthy snack (loss frame incentive). Contrary to the hypothesis that children would be loss averse and thus more response to the loss framed incentive, [List and Samek \(2015\)](#) found both incentives to be equally effective in stimulating the choice for the healthy snack. In their set up, [List and Samek \(2015\)](#) did not explore the role of key moderators such as risk perceptions of the promoted behaviour and motivational orientation of participants. Since the promoted behaviour in the study—switching to a healthy snack—can be thought of as of limited risk, risk perception may not have been an important moderator. However, the motivational orientation can still be relevant in this context.

In this paper, we study the framing effect together with the two moderators discussed above—risk perception and motivational orientations—in the context of stimulating demand for nutritionally enhanced maize among Ethiopian farmers. In Ethiopia, maize is the single most important cereal crop with 74 per cent of produce used for own consumption in 2014/15 (CSA, 2015). It is also the most important and cheapest source of calories in the country, providing 23% of per

capita calorie intake ([Berhane et al., 2012](#)). Recognizing its potential, maize has been identified as an ideal candidate for biofortification interventions in Ethiopia, ([Asare-Marfo et al., 2013](#)). However, the adoption of biofortified (nutritionally enhanced)¹ seeds is disappointingly low ([Tessema et al., 2016](#)). This paper seeks to assess whether active promotion with carefully framed messages could stimulate adoption.

This paper seeks to contribute to the literature in two ways. First, we document the framing effect in the context of a nutrition-sensitive agriculture intervention among smallholders. Most message framing studies are conducted on college students and have focussed on the health domain—disease detection ([Williams et al., 2001](#)), vaccination ([Ferguson & Gallagher, 2007](#); [Van't Riet et al., 2014](#)), and smoking cessation ([Toll et al., 2008](#)). Our results provide empirical evidence about the utility of using framed messages in a context markedly different from the context of these previous studies. Second, we contribute to the growing literature exploring the cross-fertilization of ideas and methods from economics and other social science fields such as psychology to refine strategies to promote healthy diets. From behavioural economics, we took the insight that people have reference-dependent preferences and that framing of choice problems affects behaviour. From the auction literature, we took the Becker–DeGroot–Marschak (BDM) method to elicit willingness to pay. BDM is an incentive-compatible valuation methods method that is widely used by economists in field studies. From psychology, we took the idea that people are more likely to engage in a given task when there is a match between orientation to a goal and the means used to approach that goal. Our results suggest that, by marrying concepts from different disciplines, it is possible to finetune behaviour change communication strategies in the promotion of healthy diets.

We find that nutrition education messages stimulate demand for nutritionally enhanced crops among smallholder farmers. Without nutrition education, farmers are less likely to switch from producing conventional maize to nutritionally enhanced maize. We also find that, on average, a gain-framed message is slightly more effective than a loss-framed message. This contradicts our hypothesis that farmers are loss averse and thus more responsive to loss framed messages. Our results hold when controlling for socio-demographic characteristics, farm characteristics and behavioural tendencies of participants.

We show that message framing, risk perception, and individual motivational orientation interact in important ways that determine which framing is most effective. For instance, a gain-framed message is more effective than a loss-framed one when the perceived risk associated with the new crop is low. The converse is true when the perceived risk is high. On the other hand, if the perceived risk is medium both gain and loss-framed are equally effective.

With regards to motivational orientation, we find that gain-framed messages are more effective than loss-framed messages for promotion-oriented individuals in stimulating demand for nutritionally enhanced maize seed. For prevention-oriented individuals, both gain and loss-framed messages seem to be equally effective.

These results suggest that insights from behavioural economics and psychology can be used to inform nutrition-sensitive agricultural interventions. We study the utility of these insights in the context of nutritionally enhanced crops. Nevertheless, we believe that our findings on the framing effect and the moderating role of risk perception and motivation orientation could be generalized to other types of agricultural and nutrition interventions.

The remainder of the paper is organized as follows. Section 2 summarizes the underlying theoretical framework and related literature and presents the hypotheses. Section 3 describes the context and provides details on the experimental tasks and procedures, as well as the

¹ In this paper we use biofortified and nutritionally enhanced interchangeably.

empirical strategy. Section 4 presents the empirical results, and section 5 discusses the findings. Finally, section 6 concludes the paper by discussing policy implications.

2. Analytical framework and hypothesis

Tversky and Kahneman (1981) demonstrated the susceptibility of people to framing effects. The theoretical underpinning of this phenomenon can be found in the Prospect theory of Kahneman and Tversky (1979), which argues that people have a tendency to avoid risk when a decision is framed in terms of potential gains but become risk-seeking when a choice is framed in terms of potential losses. The important prediction as it relates to this study is that risky behavioural choices (to adopt a new crop variety) will be more likely when the potential outcome of one option (decision not to adopt) is framed as a disadvantage rather than as an advantage compared to the other option (decision to adopt). This is because the value function is steeper for losses than for gains. Thus, we specify the following hypothesis.

Hypothesis 1. Messages promoting nutritionally enhanced maize seeds are more effective if they stress the negative consequences of nonadherence rather than the positive consequences of compliance. More specifically, the effect of a loss-framed message on participant wtp for a nutritionally enhanced maize seed is higher than the effect of a gain-framed message.

Building on this, Meyerowitz and Chaiken's (1987) argued that in health communication, framing effects –the effectiveness of gain-vs. loss-framed information– is moderated by the perceived risk that is associated with the advocated behaviour. Risk perception refers to people's subjective evaluation of the likelihood of a negative outcome of a given decision problem. It determines which threats people care about and how they deal with them (Paek & Hove, 2017). It is important to note that risk perception is not the same as risk preference, which refers to the decision maker's attitude to risks. While risk preferences appear to be moderately stable over time (Schildberg-Hörisch, 2018), risk perceptions are context-dependent (Ferrer & Klein, 2015). As such, different decision problems may elicit different risk perceptions from the same decision-maker.

The specific prediction is that gain(loss) framed messages are expected to elicit stronger responses when recipients perceived the advocated behaviour as less(more) risky. Several empirical studies provide evidence for this hypothesis (e.g., Ferguson & Gallagher, 2007; Hwang et al., 2012; Rothman, Bartels, Wlaschin, & Salovey, 2006; Rothman & Salovey, 1997). After conducting a meta-analysis on 94 peer-reviewed studies, Gallagher and Updegraff (2012) concluded that gain-framed messages appear to be more effective than loss-framed messages in promoting health behaviours perceived to be minimally risky to carry out. Translating this to our study, we expect farmers' risk perception to moderate the effect of our treatment. We exploit variation in risk perception among our study participants and specify the following hypothesis.

Hypothesis 2. Loss(gain)-framed messages are more effective for farmers who perceive the risk associated with producing and marketing nutritionally enhanced maize to be high(low).

Another key moderator that has received much attention in framed message research is the motivational system of individuals (Mann et al., 2004; Sherman et al., 2006, 2008). In the psychology literature, the importance of making an approach–avoidance distinction has long been recognized as a useful conceptualization of peoples' motivational system (Lewin, 1935). In approach motivation, behaviour is directed by a positive/desirable possibility, whereas in avoidance motivation, behaviour is directed by a negative/undesirable possibility (Elliot, 1999). Higgins (1998) introduced a similar characterization of the motivational system, namely promotion and prevention. Promotion oriented individuals are concerned with accomplishments and aspirations and

focus on making progress toward their hopes and aspirations, whereas prevention-oriented individuals are more concerned about safety and security and tend to focus on avoiding mistakes. Under this framework, regulatory fit is assumed to be achieved when there is a match between motivational orientation and means used to pursue desired goals. Regulatory fit increases the value of what is being pursued and strengthens engagement (Higgins, 2000, 2005). The literature refers to this as regulatory fit theory. As it relates to framed messages, regulatory fit theory predicts that gain-framed messages are more effective for approach-oriented and promotion-focussed people, whereas loss-framed messages are more effective for avoidance-oriented and prevention-focussed people.

This prediction is confirmed in several studies (Cesario et al., 2004; Mann et al., 2004). These studies showed that by directing gain-framed messages to approach-oriented individuals and loss-framed messages to avoidance-oriented focus individuals, it is possible to increase the effectiveness of messaging campaigns.

Cesario et al. (2008) provide a possible explanation as to why matching the framing of messages with the motivational orientation of individuals works. They argue that when messages are framed congruent with recipients' mindsets, message receipts *feel right* when receiving the message and their engagement with the messages increases. In the economics literature, confirmation bias –the tendency to interpret and use new information in a manner that fits existing beliefs– has long been identified as one of the heuristics that people employ when making decisions (Jones & Sugden, 2001). By combining brain imaging with financial decision tasks, De Martino et al. (2006) showed that the pattern of brain activation of subjects is different when decisions are in line with their general behavioural tendency and when they are not. This suggests that there is a neurobiological basis for the regulatory fit theory.

The key point is that the motivational orientation of individuals may accentuate (attenuate) the recipient's subjective experience of feeling right towards the advocated behaviour when exposed to framed messages so that the message recipients are more (less) likely to adopt the advocated behaviour.

Hypothesis 3.1. For prevention-oriented individuals, loss-framed messages elicit higher wtp than gain-framed messages.

Hypothesis 3.2. For Promotion-oriented individuals, gain-framed messages elicit higher wtp than loss-framed messages.

3. Methodology

3.1. Context and design

The research was conducted in West Gojjam Zone of the Amhara Region of Ethiopia. The Zone accounts for about 46% of maize produced in the region, and the region generates 25% of maize produced in the country (CSA, 2017). More than 70% of maize produced in the zone is used for own consumption. Child undernutrition is high²: prevalence of stunting is 38%, underweight 23%, and wasting around 19% (Motbainor et al., 2015). Thus, identifying effective nutrition interventions, like biofortification, is expected to lead to significant health and welfare gains.

The experiment was conducted on 648 participants in total selected from 7 districts. Districts were selected randomly from the list of maize producing districts. From each district, three or four kebeles were selected randomly from the list of maize producing kebeles. From each kebele, two villages were selected randomly. From each village, 12 farm households (four districts) or 15 farm households (three districts) were

² WHO classify stunting, underweight, and wasting high or serious when it becomes in the range of 30–39.9%, 20–29.9% and 10–14.9% in the community, respectively.

selected randomly from lists of maize-producing households. In each village, the farmers were randomly divided into two treatment and a control group. Hence, randomization was done at the individual level, stratified at the village level. Each farmer was asked to express wtp for both conventional and biofortified maize in an incentive compatible procedure.

A power analysis was conducted prior to the fieldwork and showed that the sample size allows us to detect small effect sizes.³ A pre-analysis plan (PAP) was registered in advance of carrying out the experiment.⁴ Ethical approval for research protocols, process, data management and risks related to participation in the research was obtained from the Social Sciences Ethics Committee at Wageningen University. The Ethiopia Ministry of Agriculture and Amhara regional state Bureau of Agriculture granted permission to conduct the experiment. All participants provided written informed consent.

To solicit the wtp for biofortified maize seeds for each participant, we used the BDM approach, as detailed below. In the BDM elicitation procedure, subjects individually submit sealed bids for a good. A random price is then drawn from a prespecified distribution. Individuals with bids greater than the randomly drawn price “win” the auction and purchase a unit of the good at the randomly drawn price.

While the BDM mechanism is in theory incentive-compatible, it is not the only mechanism with this property. It has been shown that the choice of auction mechanism can influence the level of bids, despite their theoretical equivalence (Lusk et al., 2004). From a practical point of view, however, one is left to choose one method, since it is generally not feasible to use multiple incentive-compatible mechanisms to elicit preferences. We chose the BDM mechanism, which has been shown to be suited in low-literacy environments (Cole et al., 2020). While this may, for example, have resulted in higher bids than random nth price bids (Lusk et al., 2004), we have no reason to expect that this choice has affected our conclusions, which do not depend on the level of the bids but only on the relative effects of the different information treatments compared to each other.

Before the BDM procedure, an audio recorded message with nutritional information was played to the two treatment groups. Group one received a gain-framed message and group two a loss-framed message about food prepared from biofortified maize. In constructing the messages, care was taken to ensure that the two messages delivered the same information and referred to the same outcomes but used different framing (See Table 1 for the exact messages.). The third group did not receive any treatment and served as a control.

3.2. Experimental procedure

Initially, the experiment was planned to be executed in groups where those assigned to a specific group would be brought into a room. However, in response to the COVID 19 pandemic, that idea was abandoned, and the procedure was executed with each participant individually.

In each village, 12 or 15 participants were invited to participate in the experiment. On the day of the experiment, each participant was informed about the objective of the experiment and that participation was voluntary. After obtaining their informed consent, participants were asked to pick a number from a box, which contained 12 or 15 pieces of paper numbered 1 through 12 or 15. Then Stata’s “splisample” command was used to split participants into three random samples of equal sizes.

³ Small effect size corresponds to Cohen’s effect-size measure f which is the standard deviation of the standardized means (Cohen, 1988, pp. 285-287) where 0.1, 0.25 and 0.4 correspond to small, medium and large effect size.

⁴ The pre-analysis plan was registered on American Economic Association (AEA) registration platform (<https://www.socialsciregistry.org/trials/6040>).

Table 1
Messages used in the experiment.

Gain-framed message	Loss-framed message
If you rely on maize as the principal daily food and consume biofortified maize ...	If you rely on maize as the principal daily food and do not consume biofortified maize ...
... your household members, children especially will be provided with sufficient protein, which performs the fundamental role of protecting the body.	... your household members, children especially will not be provided with sufficient protein, which performs the fundamental role of protecting the body.
Sufficient consumption of protein leads to better growth in young children such as height and weight.	Insufficient consumption of protein leads to poor growth in young children such as height and weight.
It will help the functions of the immune system, which works in keeping you and your family healthy	It will jeopardize the functions of the immune system, which will fail in keeping you and your family healthy
Various health problems may be prevented by adequate consumption of food that contains protein, and sufficient protein intake leads to rapid growth in children. Biofortified maize is an excellent and cheap source of protein	Various health problems are caused by inadequate consumption of food that contains protein and insufficient protein intake may delay or prevent growth in children. Biofortified maize is an excellent and cheap source of protein

To compensate for their time, farmers were given a participation fee that they could use in the auction experiment. This fee was only given to farmers who agreed to participate in the experiment. They were informed that could withdraw at any moment during the experiment without penalty, but none of them opted to do so other than a few refusals to buy seeds after a winning bid (2.7%). Since participation fees can be considered as windfall income and can influence the bid, we used two levels of fee (120 and 240 birr, or 3.6 and 7.2 USD) to control for this effect on farmers bidding behaviour.⁵ The fees were sufficient to purchase 3.3 or 6.6 kg of conventional maize seeds, which was priced at 36 Birr/kg at the time.

To increase the extent that the context in which subjects cast decisions resembles the real-life context we did the following. First, we conducted the experiment just before the planting period of maize, which is when farmers typically buy seeds. Second, we asked participants to bid for two types of maize seed: conventional maize and biofortified maize seed. In a market setting, farmers naturally compare new varieties with the conventional maize seed that they are accustomed to. By availing both seeds, we tried to make the experimental context resemble the natural environment that farmers would normally face. To control for ordering effects, the two maize varieties were offered in alternate order. Third, participants were asked to bid for the quantity of maize seeds a typical farmer would buy (3-kg⁶). One of the two bids was selected randomly, and a participant’s bid was compared to a randomly drawn offer price. When the participant’s bid was equal to or higher than the offer price, the respondent was asked to buy the maize at the offer price, and money was exchanged for the product.

We explained the BDM procedure in detail to the participants, emphasizing that the transaction must be executed if a participant’s bid was higher than the random offer price (unknown to the bidders) drawn from a distribution. We informed participants that it was to their advantage to bid the highest price they were willing to pay. Otherwise, they would run the risk that they would not be able to buy the seed, although they would have liked to buy the product at the drawn price. We also explained carefully that they could buy at maximum one bag of seeds. The type of seeds would be determined by a random draw, and

⁵ To avoid possible tension the same fee was given to all participants from the same village and the higher fee was given to the second of the two villages in a kebele.

⁶ Discussions with maize farmers in the study areas revealed that a typical farmer buys around 3 kg of maize seeds for a single production season.

whether they should purchase the seed would depend on their wtp and the offer price. This procedure was intended to ensure independence of the two bids: the farmers did not have to worry to end up with more seeds than they needed or with a combination of more preferred and less preferred seeds.

To help the participants understand the procedure better, a test round with a polypropylene grain storage bag was organized. The participants were provided with 10 Ethiopian Birr (ETB) (ETB1 = US\$0.030 in May 2020). Participants were then asked to make a bid for the grain bag. Their bid was compared to an offer price previously unknown to the bidders. They were then asked if they thought they won the bid or not and to explain why. When the bid was equal to or higher than the offer price, the respondent was reminded that this implied purchasing the grain bag. Only after the participants understood the auction procedure, the actual experiment proceeded.

As a manipulation check, all participants were asked an open-ended question to list reasons for consuming food prepared from nutritionally enhanced maize immediately after they placed their bid. Placing the manipulation check after measuring the outcome variables rather than before has been shown to be a slightly better approach in terms of reducing potential distortions (Kane & Barabas, 2019).

Finally, participants were interviewed to collect data on socioeconomic characteristics, farm characteristics, motivational orientation, and risk perception. These variables are used to study heterogeneity in treatment effects within the sample.

3.3. Moderating variables

We collected information about the motivational orientation of participants using a modified version of the Promotion/Prevention Scale by Lockwood et al. (2002). We excluded four questions from the original list of eighteen that are directly related to academic motivations (e.g., schoolwork, exams). The remaining list contained eight items related to the endeavour of aspirations and an ideal self (the promotion subscale), and eight items related to the avoidance of negative events and a feared self (the prevention subscale). Two items were very similar when translated into the local language, and during the pilot test, participants indicated that they found it difficult to distinguish between the two. So, we only retained one of these, resulting in seven promotion questions and six prevention questions. Responses were given on a 9-point scale ranging from 1 ('not at all true of me') to 9 ('very true of me').

To construct an index of motivational orientation, we used principal component analysis of factor extraction and varimax rotation of factor loads. We used an iteration approach to get the final index, removing those items that showed very low communalities and repeating the whole procedure.⁷ The final set of items comprised a total of eight items, four items for the promotion and prevention sub-scale, each. These items load highly on two factors with factor loadings >0.65 and > 0.71 for promotion and prevention factors, respectively. The two extracted factors have an eigen value greater than 1 and account for 74.2% of the variances observed. Cronbach's alpha is 0.70 for the promotion factor and 0.76 for the prevention factor, suggesting that the items have an acceptable level of internal consistency (>0.70). Since all items are measured using the same scale, the average score of items linked with the prevention sub-scale was subtracted from the average score of items linked with the promotion sub-scale to arrive at the motivational orientation score. Negative values are considered as indicative of prevention focus and positive values are considered as promotion focus.

Risk perception is measured using the widely used agricultural risk assessment framework of the World Bank (World Bank, 2016). This framework takes into account multiple risks to provide a better understanding of participants' risk perception (Komarek et al., 2020). Participants were asked to state their perceived risk of planting nutritionally

enhanced maize seeds. Specifically, they were asked about their perception of the production (yield and diseases resistance) and marketing (output price and lack of demand) risks in terms of probability of occurrence and their perception of the intensity of the impact of these risks on their food availability and farm income (World Bank, 2016). A combined score was created by taking the mean⁸ for each type of risk and categorized as highly probable (1 in 3), probable (1 in 5) and occasional (1 in 10) with regards to the probability of the event, and negligible (losses <5%), moderate (losses 5–15%), considerable (losses 15–50%) catastrophic (losses >50%) with regards to the intensity of the impact. Using the categorization rule of Table 2, participants' risk perception was coded as high, medium or low (World Bank, 2016).

3.4. Empirical strategy

The random assignment of individuals to the different treatment conditions is central to this experiment's empirical strategy. Because of this random assignment, individuals with different treatment conditions are expected to be similar in every respect except for their treatment. Any difference in outcome between treatment groups can thus be attributed to the difference in treatment.

We are concerned with estimating the average effect of the two treatments on participants' absolute and relative wtp for biofortified maize seed, with relative wtp defined as the difference in wtp between biofortified and conventional maize. To test the first hypothesis, we estimated the following regression equation:

$$Y_i = \beta_0 + \beta_1 LOSS_i + \beta_2 GAIN_i + \beta_3 R_i + \beta_4 M_i + \beta_5 X_i + \eta_i \quad (1)$$

Where Y_i is wtp and relative wtp for biofortified maize seed of farmer i ; $LOSS$ and $GAIN$ are binary response variables indicating whether a farmer is subjected to a loss or a gain-framed message; R is risk perception and M motivational orientation; X is a vector of covariates that we control for, namely household head sex, age, education level, household size, previous awareness of biofortified crops, land size, herd size (in TLU), previous maize harvest and proportion sold, and participation fee; and η_i is the disturbance term for the regression. Ordinary Least Squares (OLS) was used to estimate the treatment effects.

Looking at the distribution of the dependent variable, which is presented in Fig. 1A in the annex, revealed that a large majority of bids (87%) were multiples of 10, with most of the rest multiples of 5 and only fifteen that were not. This may reduce the power of statistical tests. However, OLS still provides consistent estimates, as OLS estimators are asymptotically normal regardless of the underlying distribution of the error (Wooldridge, 2013, p. 121). In addition, general tests of significance and hypothesis testing using t and F statistics do not require normality due to the asymptotic properties of OLS (Wooldridge, 2013, p.

Table 2
Categorization of perceived risk.

Probability of event	Severity of Impact			
	Negligible Losses <5%	Moderate Losses 5–15%	Considerable Losses 15–50%	Catastrophic Losses >50%
Highly probable (1 in 3)	Low	Medium	High	High
Probable (1 in 5)	Low	Medium	High	High
Occasional (1 in 10)	Low	Low	Medium	Medium

⁷ The output of the analysis is presented in the annex.

⁸ The mean values are rounded to the nearest unit.

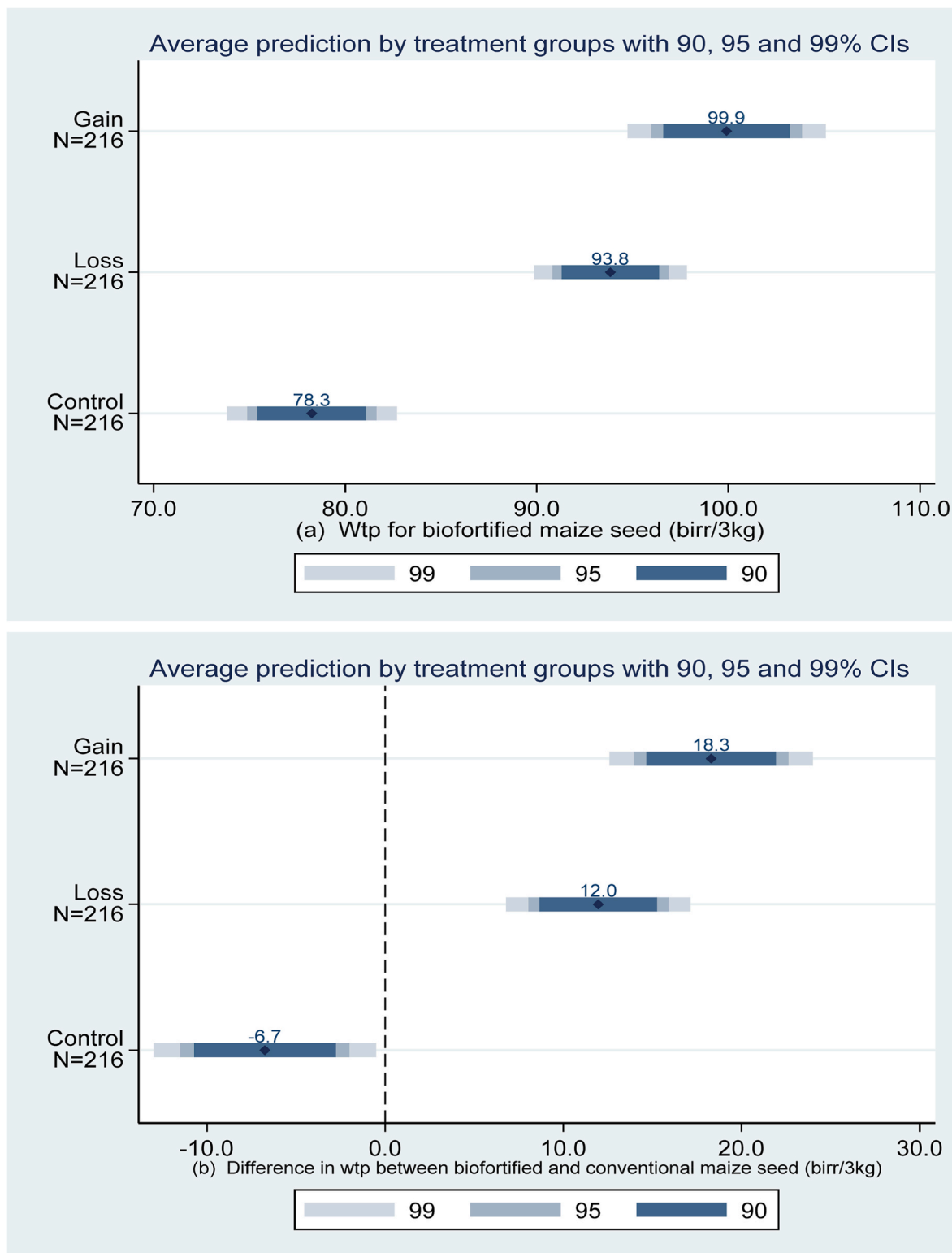


Fig. 1. The effect of an information intervention on wtp for biofortified maize seed. Note: for (a) the dependent variable is participant’s wtp for biofortified maize seed and for (b) the dependent variable is the wtp difference for biofortified and conventional maize seed. The estimates are average predictions where covariates are set at the observed value in the sample. The different shades of the bar graph represent confidence intervals at 99, 95 and 90% levels. Hypothesis testing is based on robust standard errors.

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As noted previously, our two treatments are expected to work differently for promotion and prevention-oriented individuals. The interaction effect of the treatments with these covariates is estimated by

a regression equation of the following form:

$$Y_i = \beta_{10} + \beta_{11}LOSS_i + \beta_{12}GAIN_i + \beta_{13}LOSS_i * R_i + \beta_{14}GAIN_i * R_i + \beta_{15}LOSS_i * M_i + \beta_{16}GAIN_i * M_i + \beta_{17}R_i + \beta_{18}M_i + \beta_{19}X_i + \epsilon_i \quad (2)$$

Where Y , R , M , and X are defined as in Equation (1); and ϵ_i is the disturbance term. We used robust standard errors, following the recommended practice of not clustering standard errors if treatment is assigned at the individual level (Abadie et al., 2017).

We have largely followed the PAP. The only additional ex-post analysis that we did was the inclusion of risk perception. In addition, we refrained from a few analyses in the PAP. In the PAP, previous experience with the crop was included among variables with interaction effects. However, since a large majority of the study participants (87%) said they had never planted biofortified maize seeds in the past, we excluded this variable from the analysis. The other departure from our PAP is that though we planned to analyse the treatment effect by socio-demographic characteristics such as gender, education, participation fee and awareness about the biofortified crop, we ultimately did not do these analyses. Some of the excluded variables have limited policy relevance (e.g. participation fee) while for others (e.g. household head sex and education level) we have few observations which reduce the power of our statistical test. For instance, though we planned to see the three-way interaction effect of the treatment, motivational orientations and sex of the household head, the number of females participants who received loss-framed messages with promotion motivational orientations is 10 (1.54%). Similarly, the number of participants with no education who received loss-framed messages and are categorized as promotion oriented is only 17 (2.62%). Instead, these variables are entered into our analysis as controls. We corrected p-values for family-wise error rate using the highly conservative Bonferroni method accounting for the number of hypotheses ultimately tested.

Observations are nested within villages, kebeles and districts. As a result, spatial correlation may seem to be an issue. However, by randomizing at the individual level, we avoid potential biases caused by regional differences.

4. Results

4.1. Descriptive statistics

Descriptive statistics of variables that characterize the study sample are presented in Table 3. Three-quarters of the sampled households are headed by men. On average, study participants are about 44 years old with about 3 years of schooling. About two-third of the sample have heard about nutritionally enhanced maize seed but only 16.2% have cultivated it. On average 4 people live in a household owning about 1.5 ha of agricultural land and 4 livestock units (in TLU). The farm size is higher than the national average (0.9 ha) but is similar to the average holding in high maize potential areas in the country (Headey et al., 2014).

During the production season preceding the survey period, the farmers planted 0.26 ha of maize on average, resulting in 11.5 quintals of produce (45 quintals/ha). Only 25 per cent was sold in the market, underscoring the importance of own consumption in maize production decisions. These figures are higher than the country averages where a typical maize farmer grows maize on 0.20 ha of land producing 39 quintals/ha and selling about 12 per cent of the harvest. This is not surprising, since the study is conducted in high maize producing areas. Most study participants (58.3%) rated the risk associated with adopting nutritionally enhanced maize as medium (33.3%) or high (25%).

The average motivation orientation index is -0.66 with a standard deviation of 1.88, indicating that the regulatory focus for the majority (65.4%) of the study participants is prevention-oriented –they have a heightened sensitivity to losses. The distribution of the index among the study participants is moderately skewed to the right and has slightly high excess kurtosis.

We do not find significant differences among the treatment groups except for the proportion of maize sold, which is somewhat higher for treatment group 2. This absence of notable imbalances is the result of

Table 3
Summary statistics of sample characteristics.

Variable description	Treatment group			Test statistics	ALL
	1. Gain	2. Loss	3. Control		
Sex of participants (1 = Male) f	75.0%	75.5%	75.0%	0.017 (0.992)	75.2%
Participant's age (in years)	43.5	44.3	44.9	0.86 (0.422)	44.2
Highest educational attainment (in years)	2.7	3.0	2.8	0.59 (0.554)	2.8
Household size (in number)	4.2	4.2	4.4	1.99 (0.138)	4.3
Agricultural land (in hectare)	1.50	1.52	1.52	0.06 (0.940)	1.51
Livestock ownership 2019/20PY (in TLU ^a)	3.92	3.89	4.16	0.49 (0.612)	3.99
Awareness about biofortified crop (1 = Yes) f	67.6%	69.0%	66.7%	0.268 (0.874)	67.7%
Plant biofortified maize in the past (1 = Yes) f	17.1%	15.3%	16.2%	0.273 (0.873)	16.2%
Risk perception					
Low	44%	38.4%	42.6%	3.227 (0.520)	41.7%
Medium	34.7%	33.3%	31.9%		33.3%
High	21.3%	28.2%	25.5%		25%
Motivational orientation score	-0.65	-0.82	-0.51	1.42 (0.243)	-0.66
Areas planted with maize seed in 2019/20 production season (in hectare)	0.26	0.26	0.25	0.12 (0.885)	0.26
Total maize produced n 2019/20 production season (in quintals)	10.8	12.1	11.8	0.63 (0.531)	11.5
Proportion maize sold in 2019/20 (%)	0.23	0.27	0.24	4.20** (0.015)	0.25
Observations	216	216	216		648

Note: ***, ** and * denotes means difference between the treatment group is significant at 1% level, 5%, and 10% level.

The test statistics are for the test of association among the treatment groups with p-values in parenthesis. The test used for categorical variables (f) is chi squared. For continuous variables the statistic is F. Motivational orientation of participants is measured using a modified version of the Promotion/Prevention Scale by Lockwood et al. (Lockwood et al., 2002). To capture participant risk perception, they were asked to assess the production (yield and diseases resistance) and marketing (output price and lack of demand) risks in terms of probability of occurrence and their perception of the intensity of impact of these risks on their food availability and farm income.

^a TLU: tropical livestock units, equivalent to an animal of 250 kg weight (Cattle = 0.7; sheep and goats = 0.1; horses = 0.8, mules 0.7 donkey = 0.5 Chicken: 0.01) (Jahnke, 1982).

our individual-level randomization.

All participants bid for the two types of maize seeds (biofortified and conventional). However, only one of their bids, which was selected randomly, was evaluated (their bids were compared with the offer price). Following this procedure, 319 (for conventional seeds) and 329 (for biofortified seeds) bids were evaluated (Table A5). Non-compliance (refusal to buy the maize when the bid was) was not widespread (about 2.7%) and does not threaten the validity of our results.

4.2. Manipulation check

All participants were asked to list reasons for consuming food prepared from nutritionally enhanced maize immediately after they placed their bid. The responses to this question were categorized into two groups –reasons related to possible gains/benefits from consuming and reasons related to potential losses from not consuming. To check whether those provided with gain(loss)-framed messages mentioned more gain(loss) related reasons on average, we then ran linear regressions of the number of gain (loss) related reasons that participants

mentioned as dependent variable and treatment status as an explanatory variable. Two specification –with (1) and without (2) sociodemographic covariates were estimated to check the robustness of the results (Table 4).

As expected, those provided with gain-framed messages mentioned more gain related reasons on average as compared to either of the remaining groups. Similarly, those provided with loss-framed messages stated more loss-related reasons than the remaining groups. The inclusion of socio-demographic covariates does not alter the results. In addition, the control group that did not receive any messages scored lower on both gain related and loss related reasons than either treatment group. The results provide evidence that the treatments elicited the expected difference among the treatment groups. This in turn allows us to estimate more precisely the effect of the treatment on the outcome variable.

4.3. Model estimates

We start by presenting the results of Equation (1). The full model results are presented in Table A5 in the appendix and are summarized in Fig. 1 below. The results show that wtp for biofortified maize seed was higher for those who received either of the two messages than for those who did not. We compared the relative effectiveness of the two treatments to test the predictions of the theoretical models. Contrary to the predictions of prospect theory, on average the gain-framed messages (denoted GAIN) resulted in a higher wtp for biofortified maize seed than the loss-framed message (denoted LOSS). As presented in Fig. 1a and b, the wtp for biofortified maize of farmers in GAIN was 33.3 birr/kg, which is only slightly higher than those in LOSS, which is 31.2 birr/kg, but the difference is statistically significant (Bonferroni-adjusted p-value = 0.052). We find similar results when using the relative wtp as the dependent variable. The relative wtp of farmers in GAIN is again higher than in LOSS (6.1 as compared to 4.0) and the difference is statistically significant (Bonferroni-adjusted p-value = 0.069). This gives two results:

Result 1. Nutrition education messages stimulate demand for nutritionally enhanced seeds among smallholder farmers.

Result 2. Gain-framed messages are slightly more effective than loss-

Table 4
Manipulation check.

	Dep. Var = number of Gain related reasons		Dep. Var = number of Loss related reasons	
	(1)	(2)	(1)	(2)
Gain	1.648*** (0.099)	1.645*** (0.099)	0.782*** (0.104)	0.796*** (0.103)
Loss	1.004*** (0.099)	1.000*** (0.098)	1.250*** (0.104)	1.240*** (0.103)
Constant	0.810*** (0.070)	0.878*** (0.372)	0.773*** (0.074)	0.120 (0.388)
Control for socio-demographic covariate	No	Yes	No	Yes
Adjusted R-squared	0.30	0.32	0.18	0.23
N	648	648	648	648
F test for H ₀ : Gain = Loss	41.96***	43.28***	20.20***	18.61***

Notes: The table reports the results of running a regression on the number of possible benefit(loss) associated with consumption (not consumption) of food prepared from nutritionally enhanced maize. The analysis allows us to check if participants retain some of the information from the educational message. Standard errors in parentheses. *, ** and *** denote statistical significance at 0.1, 0.05 and 0.01 level. Covariates that we control for are household head sex, age, education level, household sizes, participation fee, previous awareness about biofortified crops, risk perception, motivational orientation, land size, herd size (in TLU), previous maize harvest and proportion sold.

framed messages in stimulating demand for nutritionally enhanced seeds among smallholder farmers.

We further explore the effectiveness of the differently framed messages by assessing the moderating role of the risk perceptions. We, therefore, estimated the coefficients in equation (2). The full results are presented in Table A5 in the appendix and the relevant results are summarized in Fig. 2. Consistent with the theoretical prediction, loss-framed messages resulted in higher wtp for nutritionally enhanced maize seed than gain-framed messages for farmers who perceived the risk to be high (34 birr/kg as compared to 31 birr/kg), and the difference is statistically significant (Bonferroni-adjusted p-value = 0.018). For farmers who perceived the risk to be low, gain-framed messages were more effective. The wtp for biofortified maize of farmers in GAIN was 34 birr/kg, which is higher than those in LOSS, which is 29.1 birr/kg, and the difference is statistically significant (Bonferroni-adjusted p-value < 0.01). By comparison, there is no statistically significant difference in wtp for nutritionally enhanced maize between the two framing types for those who assessed the risk associated with adopting the new crop to be medium (Bonferroni-adjusted p-value = 0.696). We re-analyzed the moderating effect of risk preferences when the dependent variable is relative wtp and the results are presented in figure A2. Changing the dependent variable does not significantly change our main results, and this provides evidence that our results are robust. These insights lead to our next result:

Result 3. Gain-framed messages are more effective than loss-framed messages when the perceived risk associated with the new crop is low. The converse is true when the perceived risk is high. When the perceived risk is medium, the gain and loss-framed messages are equally effective in stimulating demand for nutritionally enhanced maize seeds among smallholders.

We also examined if motivational orientation moderates the relative effectiveness of loss and gain-framed messages. As summarized in Fig. 3, loss and gain-framed messages induce significantly different wtp for biofortified maize seed only for promotion-oriented individuals. For promotion-oriented individuals, gain-framed messages resulted in higher wtp than loss-framed messages (35.3 birr/kg as compared to 30.7 birr/kg), and the difference is statistically significant (Bonferroni-adjusted p-value < 0.01). By comparison, there is no statistically significant difference in wtp for nutritionally enhanced maize between LOSS and GAIN for prevention-oriented individuals (Bonferroni-adjusted p-value = 1.000). We re-analyzed the moderating effect of motivational orientation when the dependent variable is relative wtp and the results are presented in figure A3. Changing the dependent variable does not significantly change our main results, and this provides evidence that our results are robust. These data lead to our next result:

Result 4. Gain-framed messages are more effective than loss-framed messages for promotion-oriented individuals in stimulating demand for nutritionally enhanced maize seed. For prevention-oriented individuals, both gain and loss-framed messages seem to be equally effective.

These results are in line with the prediction of the regulatory fit theory, albeit partially. Our results are also consistent with the findings of studies on health behaviour change interventions where gain-framed messages were found to be more effective in promoting healthy behaviour (e.g. Gerend & Shepherd, 2013; Mann et al., 2004).

5. Discussion

We use a field experiment to investigate the relative effectiveness of framed messaging in stimulating demand for nutritionally enhanced seeds. The field experiment was conducted among smallholder maize farmers who largely produce for home consumption. We randomized farmers to receive either gain or loss-framed messages that promote

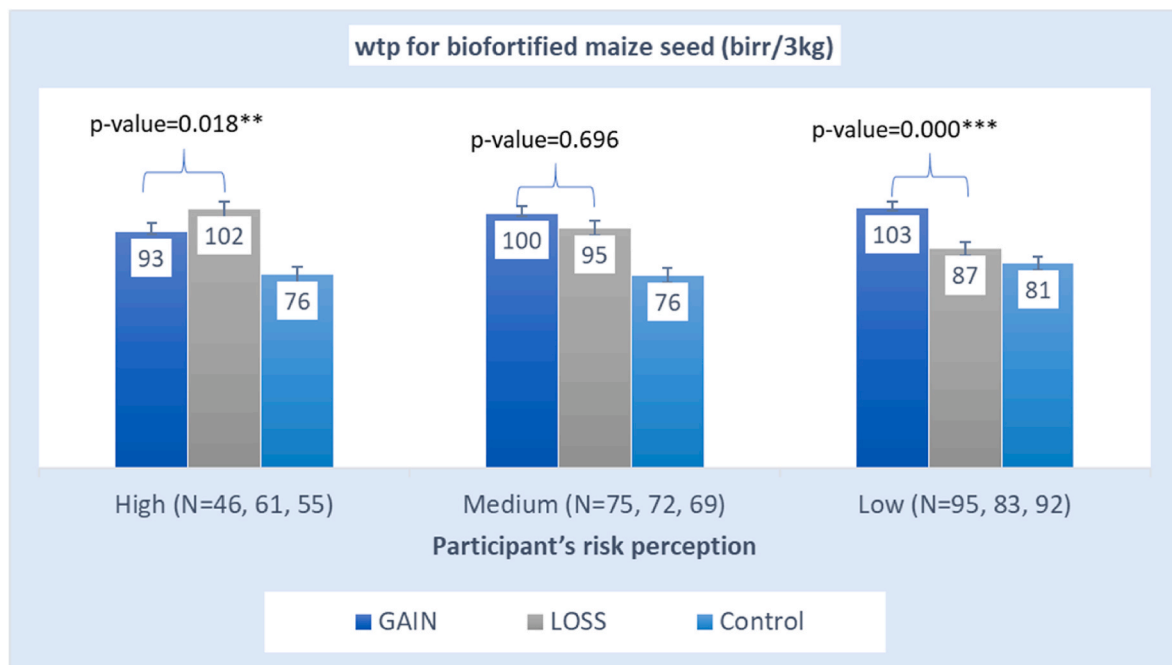


Fig. 2. Average wtp of GAIN, LOSS, and the Control groups by perceived risk. The estimates are average predictions where covariates are set at the observed value in the sample. The average predictions are derived from the coefficient table (table A6) using Stata’s - margins–command. Due to multiple hypothesis testing, the reported p-values are corrected for Family-Wise Error Rate (FWER) using Bonferroni corrections. Hypothesis testing is based on robust standard errors. *, ** and *** denote statistical significance at 0.1,0.05 and 0.01 level. N is the number observations by treatment groups.

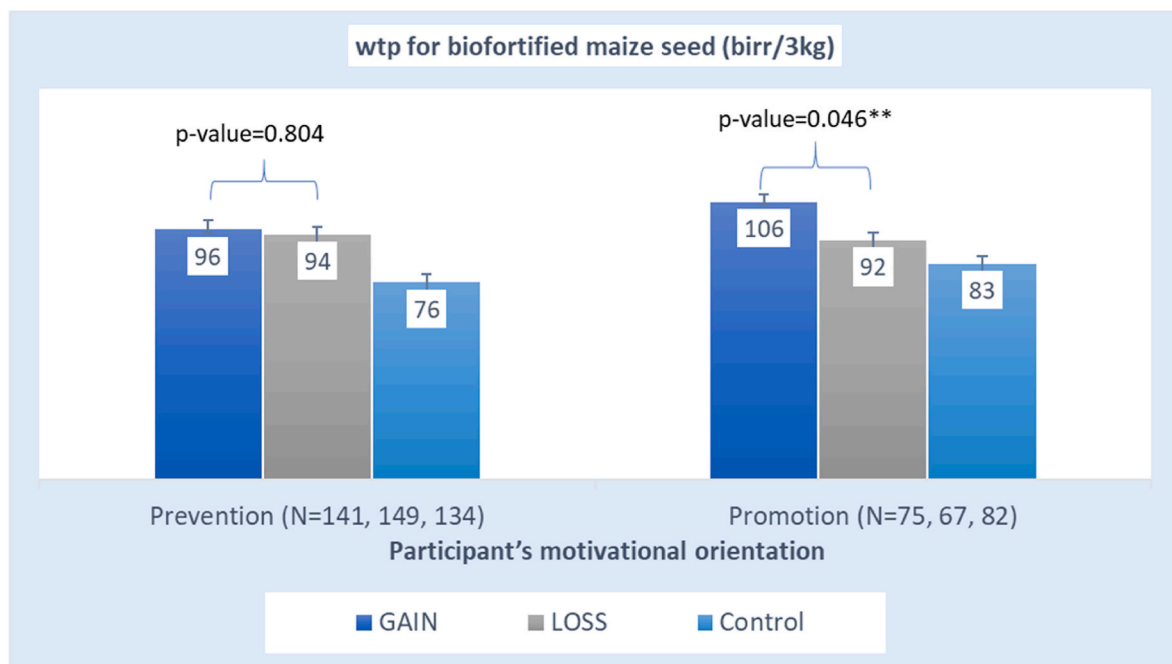


Fig. 3. Average wtp of GAIN, LOSS, and the Control groups by Motivational orientation. The estimates are average predictions where covariates are set at the observed value in the sample. The average predictions are derived from the coefficient table (table A6) using Stata’s - margins–command. The reported p-values are corrected for Family-Wise Error Rate (FWER) using Bonferroni corrections. Hypothesis testing is based on robust standard errors. *, ** and *** denote statistical significance at 0.1,0.05 and 0.01 level. N is the number observations by treatment groups.

nutritionally enhanced maize and asked them to bid for two types of maize seeds –conventional and nutritionally enhanced seeds. Our study is one of the few studies that examine the differential effect of framed messages in the dietary choice and agricultural domains and opens the door for future work exploring the framing effect to promote healthy diets or agricultural technologies.

We found that without the nutrition messages, farmers preferred the conventional maize variety over the nutritionally enhanced seeds. Our educational messages significantly increased wtp for nutritionally enhanced maize to a level higher than wtp for conventional seeds. The effectiveness of health educational messages is consistent with results emerging from the public health literature that shows a strong

relationship between nutrition knowledge and healthy food choice (e.g. Bundala et al., 2020; Scalvedi et al., 2021; Snyder, 2007; Spronk et al., 2014; Wardle et al., 2000; Worsley, 2002).

Different from the predictions from prospect theory, we find that on average gain-framed messages were more effective than loss-framed messages. We have no explanation for this deviation from the theoretical prediction. However, for a subgroup of individuals, the prediction of the prospect theory holds: We find that loss-framed messages were most effective for farmers who perceive the new seeds as a high-risk technology.

We observe that gain-framed messages were more effective in persuading farmers to buy biofortified maize seed who perceived the riskiness of adopting the new crop as low. Those with intermediate risk perceptions were indifferent between the two types of messages. The moderating effect of risk perception on framed messages that we observe is consistent with several studies in health messaging literature. For instance, Hwang et al. (2012) find that the perceived risk of sunburn moderates the effect of framed messages in promoting sun safety behaviour in adolescents. Similarly, Gainforth and Latimer (2012) found that risk perception moderate framed messages that aim to motivate women to get vaccinated. Other studies that report significant interaction between perception of risk and framed message include Maheswaran and Meyers-Levy (1990) in the areas of cholesterol screening and Gallagher et al. (2011) in the areas of screening mammography.

We also find that the dominant motivational orientation of individuals moderates the effect of framed messages. Importantly, the provision of framed messages in consonance with people's motivational orientation (GAIN for promotion and LOSS for prevention-oriented individuals) increased the effectiveness of nutrition education messages among smallholder farmers. These results are consistent with the prediction of the regulator fit theory. Similar results are reported by Lee and Aaker (2004) who showed that motivational orientation moderates the effect of message framing on persuasion and by Kim (2006) who demonstrated that by matching framed messages with people's motivational orientation it is possible to increase the effectiveness of educational interventions in preventing smoking among adolescents. Ludolph and Schulz (2015) after conducting a systematic review of 30 studies concluded that regulatory fit enhances the effectiveness of health messages. The implication is that apart from perceived risk, the motivational orientation of individuals also affects the effectiveness of framed messages.

It is important to note that promotion and prevention focus can be induced experimentally over very brief periods of time (Higgins, 1998). As such, framed message campaign may need to induce a specific motivational orientation congruent with the way the message is framed to increase its effectiveness of the messages. However, we did not examine the feasibility of experimentally inducing different motivational orientations in our study context, but rather detected the current state. This could be a consideration for future research in this area.

Taken together, these findings suggest that information interventions that aim to leverage the framing effect need to consider the moderating effect of risk perception and motivational orientation.

6. Conclusion and policy implications

Prospect theory suggests that loss framing is more effective in stimulating demand for nutritious crops than gain-framing. We find very limited evidence for this hypothesis. Instead, this paper shows how risk perception and motivational orientation moderate the effect of framed messages.

We base our conclusions on a short-term experiment. While our procedure was incentive-compatible, we cannot be completely certain that the results translate fully to an actual market situation. In addition, we did not follow participants post-intervention to determine whether the nutrition education message resulted in the consumption of food prepared from nutritionally enhanced maize, which ultimately is the

objective of the information treatment. We can only speculate that since maize is a staple and most of the produce is used for home consumption. If the nutrition education message encourages farmers to buy nutritionally enhanced maize seeds, then they are likely to produce nutritionally enhanced maize and consume food prepared from that crop.

Moreover, we cannot assess the spillover effects of the intervention. Those who received the treatment may share their knowledge about nutritionally enhanced maize seeds or neighbouring farmers may observe the performance of the new seed and adjust their perception and decide to adopt the new crop.

Despite these limitations, our study provides important insights relevant to the consumer choice and agricultural technology adoption literature. Future research should investigate the impact pathways from nutrition education interventions to improvement in food and nutrition outcomes and investigate potential spillover effects of interventions similar to ours.

Our findings have important policy implications. The context of the experiment resembles the context of the rural setting of most developing countries where biofortified crops are expected to have a significant impact on nutritional status. Our results would be relevant to those areas.

Overall, gain-framed messages are generally more effective in promoting nutritionally enhanced crops. Yet for the subgroup of people who view the new crop to be very risky, loss-framed messages were more effective, suggesting the need for a targeted approach when disseminating messages.

Our results suggest that by borrowing ideas from different disciplines, it is possible to design more effective communication strategies to promote healthy diets.

Ethical Statement

Hereby, I Kaleb Shiferaw Jada consciously assure that for the manuscript "Identifying effective message-framing techniques in behaviour change communication for healthy diets: An experimental study of promoting biofortified maize adoption in Ethiopia" the following is fulfilled:

- 1) This material is the authors' own original work, which has not been previously published elsewhere.
 - 2) The paper is not currently being considered for publication elsewhere.
 - 3) The paper reflects the authors' own research and analysis in a truthful and complete manner.
 - 4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
 - 5) The results are appropriately placed in the context of prior and existing research.
 - 6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
 - 7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.
- The violation of the Ethical Statement rules may result in severe consequences.

To verify originality, your article may be checked by the originality detection software iThenticate. See also <http://www.elsevier.com/editors/plagdetect>.

I agree with the above statements and declare that this submission follows the policies of Appetite as outlined in the Guide for Authors and in the Ethical Statement.

Data availability

Data will be made available on request.

Acknowledgement

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Appendices.

Table A1
Promotion/Prevention Scale

Using a 1–9 where 1 “Not at all true of me” and 9 “Very true of me” please rate yourself concerning the following statement.

1. In general, I am focussed on preventing negative events in my life.	Q1
2. I am anxious that I will fall short of my responsibilities and obligations.	Q2
3. I frequently imagine how I will achieve my hopes and aspirations.	Q3
4. I often think about the person I am afraid I might become in the future.	Q4
5. I often think about the person I would ideally like to be in the future.	Q5
6. I typically focus on the success I hope to achieve in the future.	Q6
7. I often imagine myself experiencing bad things that I fear might happen to me.	Q7
8. I frequently think about how I can prevent failures in my life.	Q8
9. I am more oriented toward preventing losses than I am toward achieving gains.	Q9
10. I see myself as someone who is primarily striving to reach my “ideal self”—to fulfil my hopes, wishes, and aspirations.	Q10
11. I see myself as someone who is primarily striving to become the self I “ought” to be—to fulfil my duties, responsibilities, and obligations.	Q11
12. In general, I am focused on achieving positive outcomes in my life.	Q12
13. I often imagine myself experiencing good things that I hope will happen to me.	Q13
14. Overall, I am more oriented toward achieving success than preventing failure.	Q14

Adopted from Lockwood, P. et al. (2002).

Notes: This list does not include four items related to academic achievements. Statement 5 was dropped after the pilot, as participants could not see a clear difference between 4 and 5.

Table A2
Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
Q1	-0.7247	0.5853	0.1322
Q2	0.2053	-0.2301	0.9049
Q3	0.6482	0.5895	0.2324
Q4	-0.0293	0.0815	0.9925
Q5	0.6026	0.5431	0.3419
Q6	-0.7164	0.5809	0.1494
Q7	-0.6005	0.4993	0.3901
Q8	-0.6435	0.5541	0.2788
Q9	0.2871	0.3407	0.8015
Q10	0.6415	0.5285	0.3092
Q11	0.5846	0.529	0.3784
Q12	0.3376	0.2692	0.8136

Table A3
Factor analysis/correlation

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.42262	0.91079	0.4278	0.4278
Factor2	2.51183	1.97843	0.314	0.7418
Factor3	0.5334	0.05102	0.0667	0.8085
Factor4	0.48238	0.10944	0.0603	0.8688
Factor5	0.37295	0.0841	0.0466	0.9154
Factor6	0.28885	0.03955	0.0361	0.9515
Factor7	0.2493	0.11062	0.0312	0.9827
Factor8	0.13868	.	0.0173	1

Method: principal-component factors.

Rotation: (unrotated).

Number of obs = 648.

Retained factors = 2.

Number of params = 15.

Table A4
Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
Q1	0.7926	0.5062	0.1156
Q3	-0.5863	0.6668	0.2117
Q5	-0.5559	0.6217	0.3045
Q6	0.7739	0.5019	0.1492
Q7	0.6498	0.4492	0.376
Q8	0.7012	0.4801	0.2778
Q10	-0.5935	0.618	0.2659
Q11	-0.526	0.5987	0.365

Table A5
Summary of the bidding outcomes

	Type of maize seed	
	Conventional	Biofortified
Number of participants who put a bid	648	648
Number of participants whose bid were evaluated	319	329
Number of participants who won the bid	167	192
Number of participants who actually bought the seed	163	187

Note: The table presents how many people put in a bid, how many won the bid and how many actually bought the maize seeds. The latter gives information on non-compliance: how many “had to” buy and did not buy. Though all participants were invited to bid for both type of maize seeds, only one of their bids selected randomly was evaluated.

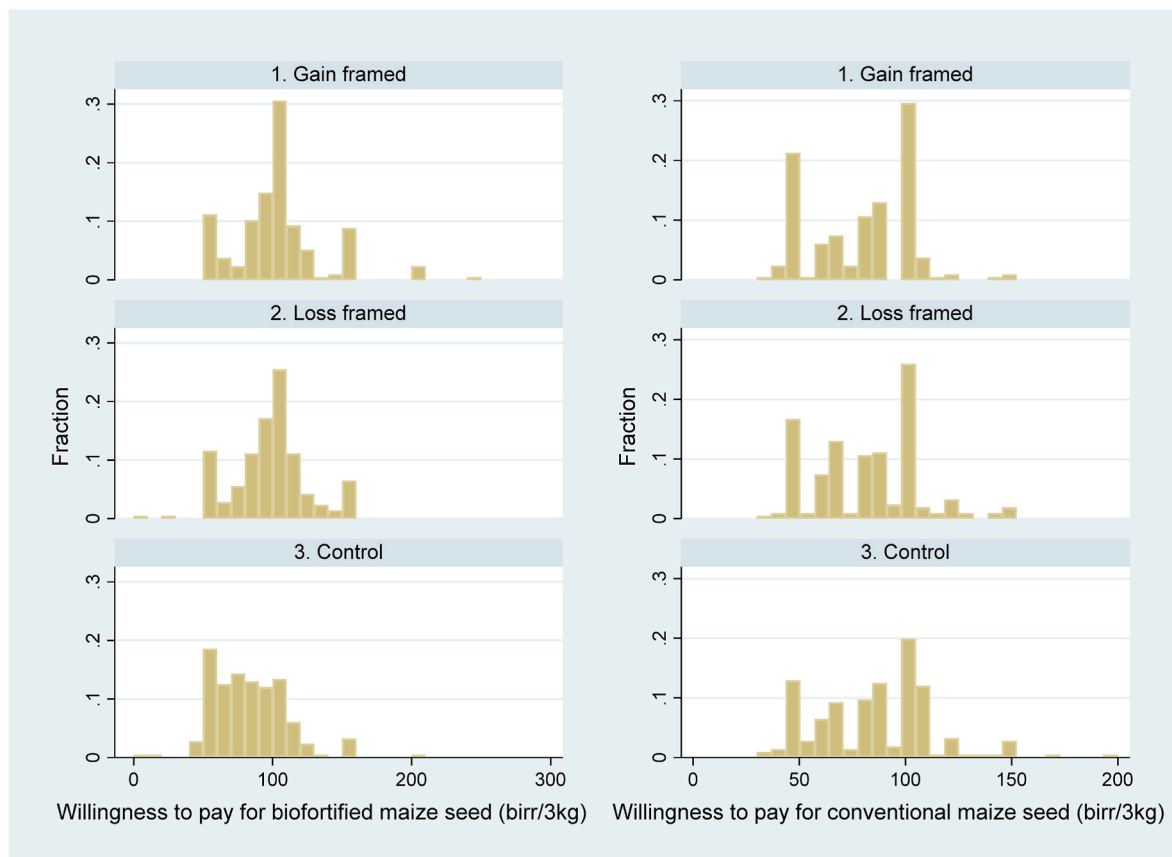


Fig. A1. Distribution of wtp for biofortified and conventional maize seed

Table A6
Results of the treatment effect by risk perception and motivational orientation.

	Wtp		Relative wtp	
	(1)	(2)	(1)	(2)
Treatment				
GAIN	21.66*** (2.64)	20.57*** (4.54)	25.04*** (3.28)	28.57*** (5.39)
LOSS	15.92*** (2.31)	8.89*** (3.23)	18.71*** (3.14)	13.06*** (4.70)
Risk perception				
Medium		-4.70 (3.49)		-1.71 (4.98)
High		-4.44 (4.75)		-11.08* (6.50)
Treatment X Risk				
GAIN X Medium		2.54 (5.89)		-7.96 (7.24)
GAIN X High		-4.92 (6.84)		-6.54 (8.65)
LOSS X Medium		12.76*** (4.75)		4.16 (6.77)
LOSS X High		20.18*** (6.32)		23.69*** (8.46)
Motivation (1 = promotion, 0 = prevention)		7.00* (3.68)		3.38 (4.98)
Treatment X Motivation				
GAIN X Promotion		3.46 (7.91)		0.87 (6.90)
LOSS X Promotion		-9.19* (8.86)		-6.86 (6.54)
Constant	27.06*** (9.17)	31.26*** (9.27)	-26.63** (12.06)	-26.84** (12.22)
Interaction	No	Yes	No	Yes
Adjusted R-squared	0.27	0.30	0.12	0.15
Observations	648	648	648	648

Notes: Robust standard errors in parentheses. *, ** and *** denote statistical significance at 0.1, 0.05 and 0.01 level. Wtp is participants' willingness-to-pay (wtp) for biofortified maize seed (birr/3 kg). Relative wtp is the difference between wtp for biofortified and for conventional maize seed (birr/3 kg). Specification (2) is the results when the two moderating variables (risk perception and motivational orientation) are interacted with the treatment. The control covariates are household head sex, age, education level, household sizes, participation fee, previous awareness about biofortified crop, land size, herd size (in TLU), previous maize harvest and proportion sold.

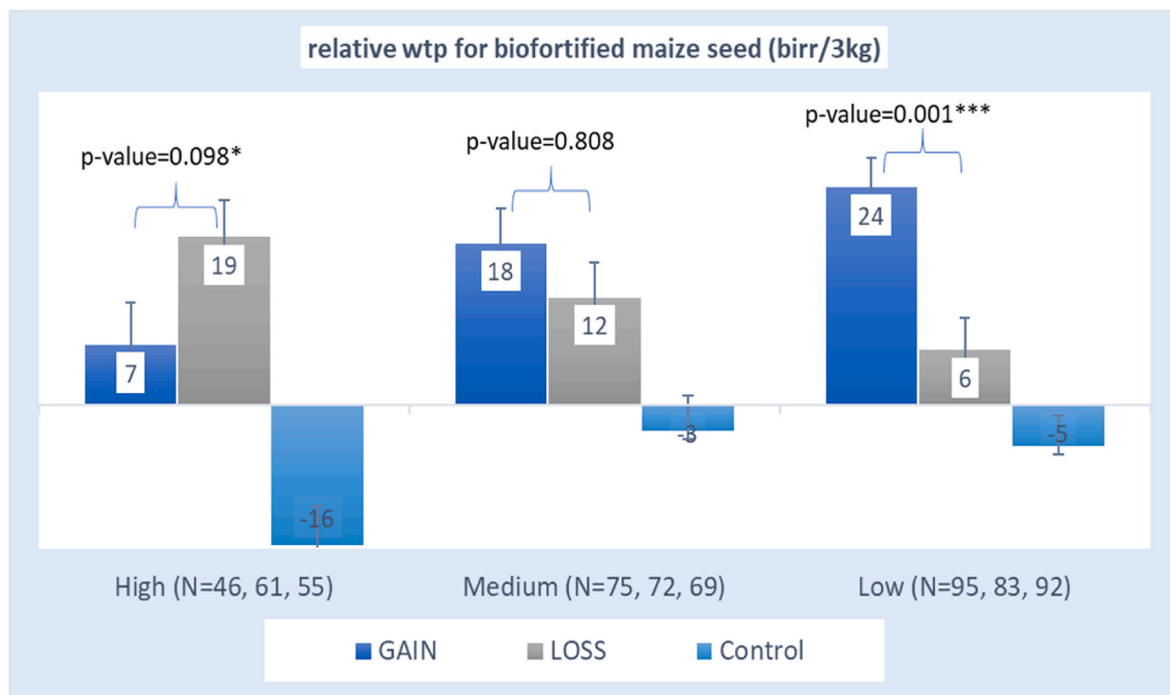


Fig. A2. Relative wtp of GAIN, LOSS, and the Control groups by perceived risk. The estimates are average predictions where covariates are set at the observed value in the sample. The average predictions are derived from the coefficient table (table A6) using Stata's - margins -command. Due to multiple hypothesis testing, the reported p-values are corrected for Family-Wise Error Rate (FWER) using Bonferroni corrections. Hypothesis testing is based on robust standard errors. *, ** and *** denote statistical significance at 0.1, 0.05 and 0.01 level. N is the number observations by treatment groups.

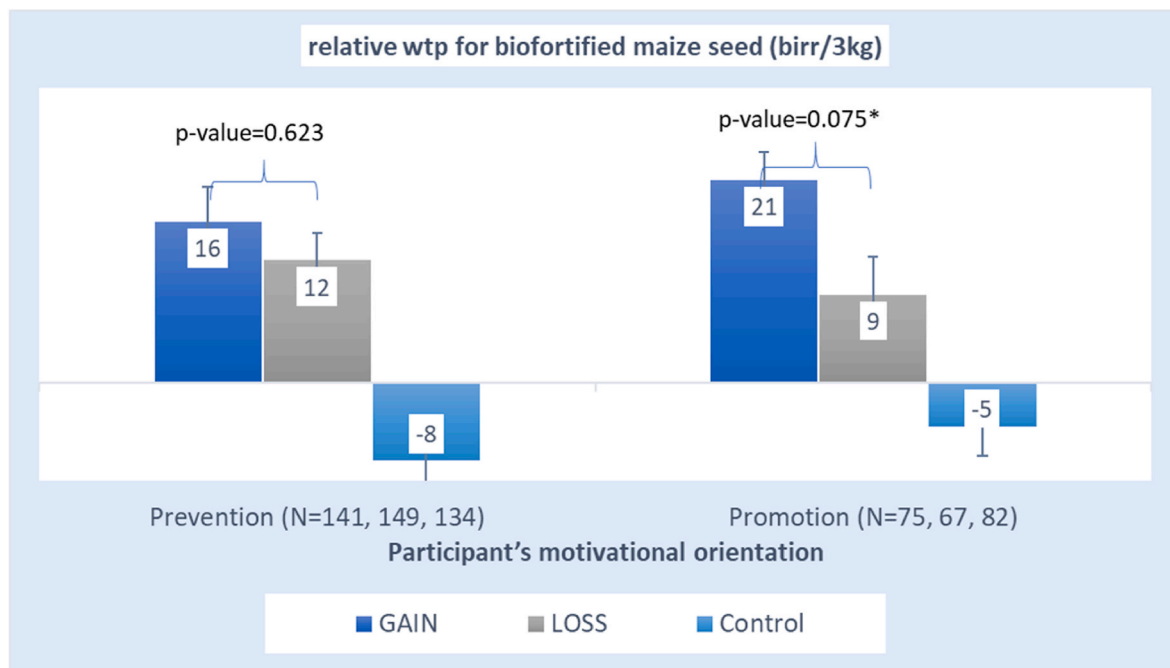


Fig. A3. Relative wtp of GAIN, LOSS, and the Control groups by Motivational orientation. The estimates are average predictions where covariates are set at the observed value in the sample. The average predictions are derived from the coefficient table (table A6) using Stata's - margins - command. The reported p-values are corrected for Family-Wise Error Rate (FWER) using Bonferroni corrections. Hypothesis testing is based on robust standard errors. *, ** and *** denote statistical significance at 0.1, 0.05 and 0.01 level. N is the number observations by treatment groups.

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